

ATMOSPHERE CORRECTION OF VEGETATION INDEX USING MULTI-ANGLE IMAGERY

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The Normalized Difference Vegetation Index (NDVI), defined as $NDVI = (L_{IR} - L_R) / (L_{IR} + L_R)$, is a good indicator of vegetation cover. Here, L_{IR} and L_R are the surface-leaving radiances in the near-infrared and red spectral bands, respectively, chosen because of the strong chlorophyll absorption shortwards of 0.7 μm . Thus, for dense vegetation, L_R generally will be much smaller than L_{IR} and the NDVI will be near unity. In addition to its use as an indicator of vegetation, the NDVI is also sensitive to variations in atmospheric CO_2 concentration, rainfall amount in semi-arid regions, and amount of canopy photosynthesis. Clearly, global monitoring of NDVI using satellite radiance measurements plays an important role in the remote sensing of the biosphere. Because this particular vegetation index is formed as a radiance ratio, it is relatively insensitive to radiometric calibration errors but, in general, satellite radiance measurements in the red and near-infrared also are contaminated by atmospheric effects, particularly aerosol scattering. For satellite observations of a vegetated area the red radiance L_R at the top of the atmosphere (TOA) will be larger than its surface-leaving counterpart due to the additional component of multiple scattered radiation occurring within the atmosphere. The counteracting effect of a decrease in the surface-leaving radiance component due to transmission extinction effects is relatively small. In the near-infrared, however, the TOA radiance is generally similar in value to its surface-leaving counterpart because the additional multiple scattered radiation component is more closely balanced in value by the attenuated surface-leaving radiance component. Thus, the NDVI, computed using the TOA radiances can be considerably smaller for a vegetated area than the corresponding NDVI, computed using the surface-leaving radiances. Since the atmospheric properties are not generally known, correction of the satellite measurements for atmospheric effects is, at best, imprecise if not impossible. There have been attempts to create new vegetation indices which are more atmosphere insensitive but so far they are still in a state of limited acceptance and usage. It is shown in this study that the NDVI, as defined above for red and near-infrared surface-leaving radiances, also can be derived from TOA red and near-infrared radiances assuming no prior knowledge of atmospheric properties, when the TOA observations also are made at a number of different view zenith angles. The analysis is a fast, simple regression procedure involving only the radiance measurements and no radiative transfer modelling. The algorithm appears insensitive to aerosol optical properties such as optical depth and phase function shape and has been tested using simulated TOA measurements, constructed from field-measured reflectance for various surface types, both vegetative and non-vegetative, and computed radiative transfer processes which used a number of different aerosol types and amounts. Instruments which routinely make multi-angle measurements, such as the airborne Advanced Solid-State Array Spectroradiometer (ASAS) and the Multi-angle Imaging Spectroradiometer (MISR) which will fly on the AM 1 spacecraft of the EOS series, can benefit from the use of such an algorithm.